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ABSTRACT

Reading is a process of forming and evaluating hypotheses to account for the data in a text. Because of its complexity, the task of reading requires strategies for controlling the proliferation of hypotheses. Four of these strategies are (1) jumping to conclusions, (2) maintaining inertia (refusing to abandon a hypothesis in spite of contradictory evidence), (3) relying on background knowledge, and (4) working backwards from the goal (choosing hypotheses that are clearly and directly related to the goal despite insufficient evidence). These strategies are necessary and are used to good effect by successful readers, but they also sometimes lead to unexpected difficulties. Understanding the reading process from this perspective of hypothesis testing can help teachers diagnose underlying causes of poor reading comprehension. Examples from oral protocols of children and adults answering questions about a reading test passage illustrate both the effective use of the strategies and some of the problems arising from their use. (RL)

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CENTER FOR THE STUDY OF READING

Reading Education Report No. 22

STRATEGIES FOR CONTROLLING HYPOTHESIS FORMATION IN READING

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Abstract

Reading is a process of forming and evaluating hypotheses to account for the data in a text. Because of its complexity, the task of reading requires strategies for controlling the proliferation of hypotheses. Four of these strategies, (a) jumping to conclusions, (b) maintaining inertia, (c) relying on background knowledge, and (d) working backwards from the goal, are generally effective, but they occasionally create reading problems, rather than alleviating them. Examples from protocols of readers reading a reading test passage are presented. These examples show both the effective use of the strategies and some problems that may arise from their use.

Strategies for Controlling Hypothesis Formation in Reading

Imagine being confronted with the following task: From a limited set of data you are to build an exceedingly complex theory. Every step of the way you will encounter ambiguities. Partial theories will be necessary, but there is no way to be sure until the end that any partial theory can be incorporated into the final theory. Almost all of the possible theories you might consider are wrong, and yet, many of them will have ample supporting evidence. You will be given the data only bits at a time; thus, you may well be sent down what linguists call a "garden path" of misleading theories. You cannot be certain that there is a single theory that best accounts for the data. Even the best theory you find may leave some data unaccounted for. You are to do theory-constructing as you gather the data. The time allotted for the task is vanishingly small, no more than the time it has taken you to read this description of it.

Faced with such a task, a reasonable person might well turn his or her thoughts elsewhere, perhaps to the ballgame outside the window; and that is what many children do when they are given the task of reading. The fact is that reading is a task with all the properties described above: The reader must build a complex theory from limited data in a short time. The data arrive pieces at a time as the eye moves across the page. Reading at a normal

pace introduces ambiguity at even the lowest level because the reader can only sample from the text. This ambiguity is magnified at the level of words and sentences. Other ambiguities arise at the higher structural levels. Theories to account for the meaning of parts of the text proliferate because the data are limited and ambiguous, and the theories can become increasingly complex as the reader tries to account for larger portions of the text. Knowledge of the world, the prior text, the author, and the purpose of reading all need to be incorporated into the theories the reader builds, but this knowledge complicates the theories further.

In this paper, we look at the process a reader must use to cope with difficulties of the kinds just described. Essentially, we view reading as a process of forming and evaluating hypotheses to account for the data in the text, and we discuss the central importance in this process of four strategies for controlling the proliferation of hypotheses. The view presented is not unique; what is different is our attempt to draw out the unforeseen implications and consequences of such a view. By taking the notion of "controlling hypothesis formation" seriously, identifying specific strategies and working through an extended example, we describe in more detail the comprehension process when it works - and when it goes awry. Our analysis does not lead to prescriptions of specific instructional methods for

reading comprehension. Instead, we hope to provide a concrete reference for teachers of reading to a perspective on the comprehension process which emphasizes

1. that miscomprehension can be due to good strategies missing the mark.

2. that even a seemingly straightforward text can lead to a large number of varying interpretations when it is read by a group of different readers.

3. that a choice between two substantially different interpretations can result from a relatively small decision in the comprehension process.

Our analysis includes both a general discussion of the process of answering questions about a reading test passage and examples from several protocols of students discussing the text. The examples both provide empirical support for the general approach and make the theory more accessible to teachers, students, and classrooms.

Hypothesis Formation and Evaluation

There is one rather obvious way to cope with a task of the difficulty described above: Collect as much knowledge as is possible and apply it at every step of the hypothesis formation process. Such knowledge is of various types. First, a reader needs knowledge of structures at the levels of letter features, letters, words, sentences, and even whole texts. She or he also needs knowledge of the meaning of these structures, such as the fact that in the passive voice construction the object of an action is in the syntactic subject position. Perhaps most importantly, the reader needs pragmatic knowledge -- knowledge about the use of language. Included in this last category are knowledge of facts about the world, knowledge of the author, knowledge of the time and place of the writing and reading of the text, knowledge of the task, and knowledge of one's own knowledge and abilities (Brown, 1980). Discussions of the knowledge needed for reading can be found in Adams and Bruce (1980), Rumelhart (1977b), Olson, Duffy, and Mack (in press), and Spiro, Bruce, and Brewer (1980). Essential among the types of knowledge needed for reading is strategic knowledge, that is, knowledge about how to use each of the above knowledge sources. Coordinating them is a complex task, as there is increasing evidence that knowledge sources interact in a heterarchical fashion; that is, although they may naturally form a knowledge hierarchy running from

orthographic knowledge to expectations about overall text structure, communication is not limited to adjacent members of the hierarchy. Earlier models of reading postulated less complicated mechanisms. The scenario proposed by Gough (1972) and LaBerge and Samuels (1974), for example, involved a visual input being processed sequentially at various knowledge levels, and arriving, finally, at a "meaning." More current models involve each knowledge source putting in its "two-cents' worth" at various points in the progression to comprehension of the text (Rumelhart, 1977a).

In viewing reading as a hypothesis-driven process (Rubin, Note 1) we define a hypothesis as a central structure which collects evidence for a particular interpretation of a text. Two general characteristics of hypotheses are important to mention here. First, a hypothesis represents a possible interpretation which may later either be proven or disproven. At various points during the reading process it may be in a state of limbo, only partially specified, needing more evidence, or perhaps even uncertain because of conflicting evidence. As a consequence of additional information, the reader may later have to "back up" and re-hypothesize about the meaning of a portion of the text. A second characteristic is that part of the structure of a hypothesis is the specification of those pieces of evidence which support or contradict it. A piece of evidence can even be

another hypothesis. Hypotheses are then linked together in a network of "supporting" and "contradicting" relations.

Several existing reading theories share significant properties with the general form described here (although they differ in important details). Goodman (1973) describes receptive language processes in general as hypothesis-based, defining them as "cycles of sampling, predicting, testing and confirming." He recognizes three levels of cues which readers use: graphemic, syntactic, and semantic; these cue systems are used "simultaneously and interdependently." Productive reading is seen as requiring strategies which facilitate the selection of the most useful cues. Smith (1973) emphasizes the contribution of what he terms "nonvisual" information to reading. This nonvisual knowledge includes what people already know about reading, language, and the world in general. He argues particularly that reading is not decoding to sound, but rather that semantic and other nonvisual processes intercede between visual processes and reading aloud. A different approach, which nevertheless assumes a hypothesis-based process is that of Perfetti (Note 2). He suggests ways in which the various component processes might interact, basing his overall conclusions on the fact that all the processes which occur during reading comprehension must share a "limited capacity processor."

The limited-capacity processor view suggests a potential problem in the use of knowledge for reading comprehension: Although different types of knowledge are needed to evaluate hypotheses, each chunk of knowledge may also aid in the construction of new hypotheses. Thus, evaluation and, hence, elimination, of hypotheses vies with new hypothesis formation in determining the size of the hypothesis space. What is needed are strategies for controlling the proliferation of hypotheses. Details of such strategies have been discussed elsewhere (Collins, Brown, & Larkin, 1980; Erman, Hayes-Roth, Lesser, & Reddy, 1980; Woods, 1980; Rubin, Note 1). The point we will make here, however, is that strategies that cut down the number of hypotheses for consideration have other, qualitative effects, as well.

We assume that these strategies operate within a process that maintains many hypotheses at once, but actively works on only a few at any one time. New hypotheses are spawned from the ones under active consideration. Thus, a strategy for focussing attention on one hypothesis out of a set of competing hypotheses (or choice set, [Rubin, Note 1]) would limit the number and type of new hypotheses that are generated.

We have identified four such strategies:

1. jumping to conclusions (choosing one hypothesis out of a choice set and focusing on it despite insufficient evidence)

2. maintaining inertia (refusing to abandon a hypothesis in spite of contradictory evidence)

3. relying on background knowledge (using prior knowledge to choose a hypothesis from a set of otherwise equally possible ones)

4. working backwards from the goal (choosing hypotheses which are clearly and directly related to the goal despite insufficient evidence)

A system using these strategies can begin to cope with a task such as reading. But things do not always go smoothly. The very features that enable the system to handle uncertainties cause it to have somewhat peculiar properties, which may account for both difficulties and successes in reading. In the next section we see how a hypothesis-driven system with these strategies might operate in reading a simple story, and, in the following section, how it may also produce misunderstanding. Finally, we discuss a perspective on reading instruction that may

be drawn from these examples.

Hypothesis-Driven Comprehension of a Simple Story

If the reading process is in fact hypothesis-driven, we would expect to see evidence of this characteristic in people's reading behavior. In this section, we analyze a short passage and describe how a hypothesis-driven process might answer comprehension questions about it. The passage is taken from the Educational Testing Service's Cooperative English Tests (1960). Although we use a test passage and the accompanying test questions in our discussion, our purpose is not to criticize the test, but to explore the processes involved in understanding a passage well enough to answer questions about it.

"Alice!" called a voice.

> The effect on the reader and her listener, both of whom were sitting on the floor, was instantaneous. Each started and sat rigidly intent for a moment; then, as the sound of approaching footsteps was heard, one girl hastily slipped a little volume under the coverlet of the bed, while the other sprang to her feet and in a hurried, flustered way pretended to be getting something out of a tall wardrobe.

Before the one who hid the book had time to rise, a

woman of fifty entered the room and, after a glance, cried, "Alice! How often have I told you not to sit on the floor?"

"Very often, Mommy," said Alice, rising meekly, meantime casting a quick glance at the bed to see how far its smoothness had been disturbed.

"And still you continue such unbecoming behavior."

"Oh, Mommy, but it is so nice!" cried the girl. "Didn't you like to sit on the floor when you were fifteen?"

The first question on the comprehension test is:

1. Alice's companion was

    a. a girl
    b. her brother
    c. the family dog
    d. a doll

In order to answer this question, the reader first must identify the characters in the story and decide which one corresponds to each referring expression in the text. This is no simple task, as several different characters are introduced in the first few lines of this story. One coherent hypothesis

identifies three separate people: the owner of the voice (later to be identified as "Mommy"), the reader (also described as the "one girl" who "hastily slipped a little volume under the coverlet of the bed"), and the listener (hypothesized to be "the other" who "sprang to her feet"). There are several other only slightly less coherent hypotheses, however, which a reader could easily construct. Certainly the book-hider could be the listener and the wardrobe-looker the reader, rather than vice-versa. Or some readers might postulate that five different people are described, judging the link between "the reader and the listener" and the two girls to be insufficiently clear. In fact, if "another" is substituted for "the other" preceding "in the room sprang to her feet," this link is effectively broken and the number of people in the room becomes unclear. The question itself, which asks about Alice's companion (not companions) actually provides some of the most straightforward evidence that there are only two people in the room when the story opens.

Even if a reader has settled on the interpretation that identifies two girls in the room, further inferences must be made to demonstrate that one of them is Alice. A hint is offered when the "woman of fifty" reprimands one of the girls by name. But interpreting this hint correctly requires postulating that the woman is in fact addressing "the one who hid the book" and, furthermore, that "the reader" described several lines earlier is

the same character. If all of these inferences are made and coordinated, the reader of the passage can conclude that Alice's companion was a girl.

The second question is what has been called an "inferential" question and introduces the possibility for even more complex hypotheses:

2. When Alice heard the approaching footsteps, she probably was:

    e. angry
    f. alarmed
    g. puzzled
    h. amused

In order to answer this question, the reader must first be able to identify Alice and decide which of the actions described in the story should be attributed to her. As explained above, this in itself involves several plausible hypotheses, and we can add here that it is possible to answer the first question correctly without deciding that Alice is the one who hid the book rather than the one who occupied herself with the wardrobe. Whichever girl is Alice, the description "started and sat rigidly intent" will be relevant to any hypothesis about her reaction, since both girls acted the same. However, this reaction is

easily interpretable as either alarm or anger, and the reader must use additional information from the text to decide between the two hypotheses. All the other relevant details occur further on in the text than the description of the incident we are interpreting. Alice hides a book "hastily" and later seems concerned that her mother not discover that it is under the coverlet. These actions suggest guilt, but they do not definitively discriminate between alarm and anger, which are both plausible reactions to feeling guilty. In fact, it seems that one of the few phrases which help the reader determine that Alice is alarmed is "rising meekly"; if Alice had in fact been angry, she most likely would have acted more aggressively. In this case, an "incorrect" hypothesis has almost as much supporting evidence as the correct one.

The third question is:

3. We may infer that Alice is:

    a. stupid and resentful
    b. very much in love
    c. fifteen years of age
    d. a spoiled child

The phrasing of this question alerts us to the fact that inference will be particularly important (although we have just

seen that inference is always important). In fact, choosing answer c -- that Alice is 15 -- is risky at best and in no way "provable"; a plausible case could be made for several of the choices. Deciding on c requires knowledge of a strategy: "if you're being blamed for something, attempt to elicit the sympathy of the blaming authority by getting them to admit they've done the same thing." In order to infer that this strategy is being applied here, the reader must first realize that Alice is being blamed for sitting on the floor, a conclusion which follows fairly directly from the mother's first question, Alice's meek response, and the mother's follow-up question. Then we must note that, in speaking to her mother, Alice has added a piece of information to the description of her action which (under this hypothetical persuasion strategy) indicates she is herself 15. It is worthwhile noting that almost all of these conclusions are based on the reader's understanding of the implications of speech acts (see Cohen & Perrault, 1979). For example, although Alice's final remark is syntactically a question, its real purpose is to persuade, not to gain information. Neither is her mother's "How often have I told you not to sit on the floor?" really a question; it is closer to an accusation. The inference of guilt is based on the reader's knowledge of the social conventions surrounding the speech acts and of mother/child relationships.

Given that we understand, at least sketchily, how the reader

might conclude that Alice is 15, we are still faced with an important problem in understanding how one can answer this question. The problem is one of control structure: How does the reader choose this particular reasoning path out of all the possible ones to follow? Another set of inferences might lead the reader to conclude that Alice's mother is a stern person, but a reader cannot afford to entertain all possible conclusions. In this case, reasoning backward from the question allows the reader to choose the most relevant paths to follow. Good test-takers read over the possible answers to multiple-choice questions and use them to guide their detailed thinking. In this case, in considering answer c, the reader focuses on the final paragraph where there is a reference to age, and attempts to construct a link back to the answer. We can get some feel for the distinction between inferences made while reading the story and those made in response to questions by considering the comparison between a description of Alice given just after reading the story and a description given after answering the questions. Mention of Alice's age would be much more common in the second description; although the information necessary to infer her age is present in the story itself, the actual inference is probably not made (or not remembered) unless explicitly asked for.

There is more evidence of question-directed inference in the fourth question:

4. When she heard her name called Alice was evidently

e. reading to herself

f. reading aloud

g. lying in bed

h. making her bed

We know fairly directly that a "reading aloud" is taking place from the phrase "the reader and her listener." By following the chain of references through the next several sentences, we can infer that it was Alice who hid the book. However, we have no reason to believe that Alice was reading rather than listening; the fact that she hid the book supports this hypothesis, but does not confirm it. A "process of elimination" strategy is necessary to answer the question. In this case, two of the other three possible answers are easy to rule out. The only other answer which makes some sense is e -- reading to herself. Alice might have been reading to herself while her companion read out loud, possibly from the same book. Such a hypothesis requires only a little more extrapolation than the "reading aloud" hypothesis.

One implication of these last two examples is that a child may do better on a reading test by using certain strategies which might be termed test-taking skills. These strategies are examples of reading with a goal, and they must be considered part

of the knowledge necessary to perform well on such reading tests. The existence of such question-based inference strategies also points out a weakness in determining the difficulty of a text *in vacuo*, i.e., outside of a task definition. It is easier in general to check whether or not a given fact is consistent with a story than it is to answer a more general question.

Finally, the fifth question:

5. Alice was worried about the appearance of the bed because

    a. she had neglected to make it up
    b. her companion had been sitting on it
    c. her companion was hiding under it
    d. she was afraid her mother might find the book

Answering this question is closely related to answering Questions 2 and 3; it requires a global hypothesis about the interaction between Alice and her mother. While the exchange between them demonstrates anger on the mother's part and guilt on Alice's, the topic of their disagreement is *not*, in fact, Alice's real concern. If it were, the answer might be *b*. In fact, it is not too difficult to construct a hypothesis with supporting evidence which would lead the reader to this response. For a reader unfamiliar with the word "coverlet," it may not be clear

that the act of hiding the book changed the appearance of the bed. (Consider the difference in effect if the word had been "dust ruffle.") Such a reader might, in reading the fourth paragraph, hypothesize that Alice was concerned that the bed might be rumpled because someone had been sitting on it, since the conversation Alice is having with her mother at this point is about sitting in inappropriate places. This hypothesizing process would lead the reader to choose b as the answer.

The hypotheses which lead to the "correct" answer d are no less complex. We have already discussed the inference that Alice is the one who hid the book under the coverlet; the final move to comprehending the relationship of that action to her mother requires some pragmatic knowledge about why people hide things. In a little more detail, the inferential process might proceed as follows:

Fact from story: Alice hid the book under the coverlet.

Real-world knowledge: People hide things so that other people won't find them.

Hypothesis: Alice hid the book when she heard her mother approaching. (From the beginning, Alice knew who it was, although we did not.) When her mother was in the room, Alice was worried about the bed.

Real-world knowledge: Hiding something means you worry about the other person finding it when they are around.

Conclusion: Alice was afraid her mother might find the book.

The reader finally arrives at an answer after a long and sometimes tenuous chain of inferences.

In a slightly more rigorous way, we can describe 12 different, reasonably coherent interpretations of this story based on three separate ambiguities. The first ambiguity involves the number of girls in the room. We have already seen how the information given does not clearly answer the question "How many girls were in the room?" and we will describe below how readers made arguments for the answers "One," "Two," and "Three." Two of the protocols below also highlight two possible hypotheses explaining Alice's alarm when she hears her mother's footsteps; readers decide that she is concerned either about being caught with the book or about being caught on the floor. They also differ in their attribution of motives to Alice. Some feel she is sitting on the floor when her mother arrives because she did not have time to get up, but others feel it is a deliberate attempt to distract her mother from the book hidden under the covers of the bed. Taking all possible combinations of options

on these three points, (3, 2, and 2 options, respectively), we can construct 12 interpretations of the story. With hypotheses proliferating in this way, it's no wonder readers resort to powerful heuristics for limiting the possibilities they entertain.

Strategies for Controlling Hypotheses

The examples in this section illustrate four mechanisms for controlling the proliferation of hypotheses. They are drawn from oral protocols of children or adults answering questions about the above passage after reading it. All four demonstrate ways in which these hypothesis-limiting strategies can go awry, leading the well-intentioned reader to the wrong conclusion.

Jumping to Conclusions

At the beginning of a text passage, the opportunity and necessity of jumping to conclusions with insufficient evidence is greatest. The reader has only a limited amount of information and the number of plausible hypotheses is large. Obviously, the accepted conclusions are sometimes wrong:

Questioner: How many people do you think were in the room altogether before her mother came in?

John[1] (an 11-year old boy): Including Alice, I think three. Yea, because one's putting up the wardrobe . . . no, maybe one . . . two or three, I'm not . . . I'm sure it's in there.

Q: Why don't you say what you think and then look back and see if you think something different?

J: Sure. I think it was three. Because one of them put the book under the bed and one sprang up to the wardrobe and if Alice was sitting on the floor at the same time and didn't have a chance to get up, then I would pretty much presume that one couldn't have done both those things before Alice could get off the floor. I'll look back now.

Q: Okay . . . you want to look back now?

J: Sure. Ah . . . yes . . . "one girl hastily slipped a little volume" . . . it could be two . . . oh, there are only two of them . . . there's a reader and a listener and it

was Alice who put it under the bed.

In this excerpt, we can see that John decided there were three characters in the room because he did not take all the evidence into account. He focused in his inference on figuring out whether or not the same person who was standing at the wardrobe had hidden the book, taking for granted that Alice, who remained on the floor, did neither. John essentially missed the implication of the first line of the third paragraph ("Before the one..."), which clarifies the fact that Alice was the one who hid the book. While his strategy simplified the comprehension process, it led him to the wrong conclusion. Notice that John, who is quite a sophisticated reader for his age, had the ability to analyze and alter his hypothesis in the face of new evidence; this capacity is crucial for remedying the effects of jumping to conclusions.

Maintaining Inertia

A rather surprising example of a reader's tendency to cling to hypotheses even in the face of some conflicting evidence occurred when Karen, a well-educated, literate adult, read the passage and answered the comprehension questions. As it turns out, she answered only 2 out of the 5 questions "correctly." Examining the hypotheses this subject reported in her summary,

however, we found that she had carefully and properly articulated a "garden path" hypothesis (that is, one which is plausible except for some easily-overlooked piece of refuting evidence.)

Karen made only one true mistake: She failed to connect "one girl . . . , while the other . . . " with the idea of two girls. Therefore, in her recall, Alice both hid the book and went to the wardrobe; she was also sitting on the floor when her mother entered the room. Like most readers, the subject felt obliged to account for why the book was secret; she assumed that it had to be a diary. Karen paid more attention to Alice and her motives in understanding why she hid the book than do most readers; usually readers think the mother would consider reading the book to be sufficient cause for blame. Her scenario, then, was that Alice was sitting on the floor by herself, reading her diary, when the story opened.

In answering the first question, Karen felt that, given the options, <u>doll</u> was the best answer. Little girls do read to their dolls, and a fantasy world is the safest place for a diary's secrets. Since the subject didn't identify "the reader and her listener" with "one girl . . . , while the other," the usual path to answering this question was blocked. Therefore, she was obliged to rely on a longer chain of more tenuous question-time inferences.

The second question was answered conventionally; as discussed in the last section, Alice hurried to hide the book, so she must have been alarmed.

The third question, beginning "We may infer that," suggested to the subject that further inferences were called for. Having already concluded that Alice was 15 years old, she regarded that conclusion as explicitly stated, not inferred. Here again, the supposition that Alice was reading her secret diary figures prominently in the sequence of steps Karen took to the conclusion. Alice could most plausibly be "very much in love" because that would be recorded in her diary, and a girl of 15 would especially not want her mother to know that.

The fourth question was answered reasonably given the episodic structure set up to answer the first question. This structure says that when her name was called, Alice was reading to "her listener," the doll. The subject chose to describe it as "reading to herself" rather than "reading aloud" because the doll was only being read to in Alice's imagination. "Alice was evidently reading to herself."

At this point, it seems that Karen has really stretched her hypothesis beyond the limits of feasibility. She has had to

make the same initial hypothesis. Yet, at each point it is easier for Karen to continue to elaborate her hypothesis than it is for her to abandon it and construct an entirely new one. Her tendency to follow the implications of her initial reaction has led her down the wrong path, even though such a strategy is in general quite effective.

Relying on Background Knowledge

Carol, a fifth grader, illustrated the third strategy in her interpretation of the text. When a passage is difficult and too many hypotheses suggest themselves, a reader may focus on those which are most strongly supported by his or her own background knowledge.

Carol found the story difficult and had to read it through twice; part of her discussion with the interviewer follows:

Q: Can you remember one specific thing you felt you didn't understand the first time and how it helped you when you read it again?

C: I think about the volume and the coverlet and the tall wardrobe and I didn't really understand that but when I read it over again I said "oh yeah." I don't know why the mother didn't want her to sit on the floor. I mean MY GOD! I mean I spend half

of my life on the floor.

Q: Can you do the summary thing again? Tell us again in a few sentences?

C: Umm, there was two girls and I think this is what happened, she had a friend over or something and that one person who's reading the book to the other person and then they heard the mother come in and then the mother got all upset because she was you know, they were reading on the floor and the - umm, I think it was Alice, the one girl or something said didn't she sit on the floor when you were fifteen and I was a bit sort of flabbergasted at why would someone get so upset about you know sitting on the floor.

Q: Why did Alice slip the book under the covers of the bed do you think?

C: I have no idea, I don't if she (inaudible) trying to put it in her bookcase, I mean if her mother gets so upset that she's sitting on the floor I think she would take a fit that she saw a book on the floor or (inaudible)

Q: You think Alice's mother had ever been angry with

her before for sitting on the floor?

C: Yes because she said how many times have I told you, actually my mother will do that when it's the first time I have ever done it, I think (inaudible) nervous reaction. They sort of want to scare the kids, you know.

We can see from these excerpts that Carol drew heavily from her own interactions with her mother, commenting on both similarities and differences between the story and her experience. The reason she understood the story better the second time was that she had read the part in which Alice's mother gets angry at her for sitting on the floor. This interaction gave her a framework within which to understand the rest of the story, so she returned to the beginning of the story and interpreted Alice's earlier actions in the same light. Based on her hypothesis, Carol decided that Alice's major concern all along had been that her mother would see the book on the floor. In a sense, Carol seized on the one incident in the story that struck a responsive chord for her and used it as her perspective for viewing the whole. In so doing, she misunderstood the beginning of the story -- in particular, Alice's motives -- but constructed for herself a coherent interpretation. In this way,

individual bits of background knowledge may have an inordinate effect on a reader's interpretation, as much of the text is funneled through a narrow interpretive channel.

Working Backwards from the Goal

We return to Karen's protocol for an example of the fourth hypothesis-limiting strategy. We have already seen how Karen constructed a coherent misinterpretation of the passage. In answering the questions, Karen used the important test-taking skill of working backwards from the possible answers. This strategy forced her to integrate the presuppositions of her chosen answers into her hypothesis. Thus, her "wrong" answer for Question 1 strengthened the diary hypothesis, which was therefore trusted again in Question 3. Her answer to Question 4 was based on her answer to Question 1. Indeed, from Karen's point of view all of the questions were based on understanding Alice's diary: its audience, its import, its content, and its secrecy. For Karen, a central strategy for comprehending test passages and limiting hypotheses backfired and in the process of answering the questions, she became more deeply entrenched in her own version of the story.

A Perspective on Reading Instruction

The examples in the previous sections exemplify both the power and potential dangers of hypothesis-limitation strategies. Although meaningful reading could not exist without some such strategies, readers and teachers must also be aware of their potential to lead to misinterpretation. This means that diagnosing reading difficulties may be more difficult than it first appears. Our measures of comprehension invariably freeze the process of comprehending to look at some product, which may over- or underestimate the reader's comprehension of the text. The hypothesis-based view we have presented identifies dimensions on which the product may not accurately reflect the reader's comprehension. Getting the right answer may be a result of jumping to a conclusion on the basis of what would ordinarily have been insufficient evidence. A wrong answer may reflect the construction of a hypothesis only distantly connected to the question.

For the task of simple arithmetic problems, it has been shown (Brown & Burton, 1978) that one's first intuitions about the source of a student's difficulties can be far off the mark. Moreover, a simple, underlying misconception about arithmetic procedures may manifest itself in a variety of surface errors. For the much more complex task of reading, we should expect more

difficulty in discovering underlying misconceptions which affect the process.

There is one saving grace: The very intricate interconnectedness of the hypothesis network can be turned to advantage. Rather than insisting that an error be traceable to a misreading of one phrase of the text, we should be more inclined to explore the reader's entire structure of reasoning about the text.

"Carelessness" is a attribution that says we do not understand details of the reader's hypothesis instantiation process. The reader (Karen) who missed 3 of 5 questions on the story about Alice was careless, to be sure, but all readers are careless in that sense. It is carelessness with respect to specific parts of the text and a specific hypothesis that leads to difficulties. Successful fast reading occurs when the reader's intentional carelessness causes the reader to miss only the bits of evidence that support incorrect hypotheses or contradict correct ones.

Another characteristic of a hypothesis-driven process derives from the power inherent in having knowledge of the task. By drastically reducing the number of relevant hypotheses, such knowledge increases one's reading effectiveness, but, of course, only with respect to the given task. This explains why asking

questions before reading is so effective. A question defines the task for the reader, thereby suggesting which hypotheses are most worth developing. Asking questions after reading can similarly focus a reader's interpretation (or re-interpretation) on specific aspects of the story, as was shown in our Alice story protocol.[2]

Closely related to the issue of specific questions is that of understanding the general purpose for reading a particular text. Reading with a different understanding of purpose from that of the author or another reader can lead to radically different interpretations of a text or to comprehension difficulties (see Adams & Bruce, 1980). Perhaps some readers' difficulties may be traceable to their failure to read with a purpose, or to their working towards inappropriate goals.

These considerations suggest that it is essential to ensure that the reading task involve a credible purpose and that the text itself not betray that purpose. It is too often the case that the communicative function of a text, e.g., to persuade, to inform, to entertain, or whatever, gets obscured in the processes of simplifying, standardizing, and so on, that are carried out before its inclusion in a school book. When students are trying to master a skill as complex as reading comprehension, they need and deserve texts that provide clear purposes that help control

the hypothesis formation process.

Conclusion

One of the great frustrations for a writer is that thoughts can never be completely and accurately encoded into words. It is impossible to draw the line that says, "this thought is not relevant to the present issue." Also, words themselves have histories of personal use which call forth both wanted and unwanted meanings. What a writer can do is to suggest, to point, to indicate, or at most, to draw a blueprint. It is then the reader's task to create anew from that blueprint a meaning that, to the extent that communication succeeds, matches the writer's salient thoughts. Reading is not decoding symbols, but creating meaning from symbols.

As a creator of meaning, the reader draws on many resources, especially various kinds of knowledge and the ability to construct hypotheses. Equally importantly, the reader has strategies for applying this knowledge, strategies which limit the proliferation of hypotheses. These strategies are necessary and are used to good effect by successful readers, but they also sometimes lead to unexpected difficulties. Understanding this process is an essential part of our understanding of reading. The perspective this viewpoint affords can be an aid to teachers in thinking about the underlying causes of poor reading comprehension.

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Footnotes

[1]All names used in this paper are fictitious.

[2]Similar results have been found in research on perspective-taking (Anderson, Pichert, & Shirey, 1979).

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